

# Amphibians of the Sinos River Basin, southern Brazil

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## Abstract

The Sinos River encompasses a wide area of natural habitats and, at the same time, supports one of the highest population densities of southern Brazil. Consequently, natural habitats along the Basin present a high degree of habitat disturbance. Despite of the existence of threatened species, information about diversity of amphibians in that area is scarce. Thus, we aimed to catalogue the amphibian species of the Sinos River Basin from records in scientific collections and compilation of published articles. We recorded 52 species, all with geographic coordinates validated at the collection point, indicating that the Sinos River Basin harbours about 50% of the amphibian species of the State of Rio Grande do Sul. Three anuran species were classified as having some degree of threat: *Melanophryniscus cambaraensis*, *Melanophryniscus dorsalis* and *Thoropa saxatilis*. We also expected other 18 species with a high probability of occurrence in the Basin. This work shows that, despite the intense human impact, the Sinos River Basin has a relevant role for the maintenance of a considerable fraction of the amphibian biodiversity in southern Brazil.

**Keywords**

Anura, Atlantic Forest, conservation, grasslands, amphibian inventory

**Introduction**

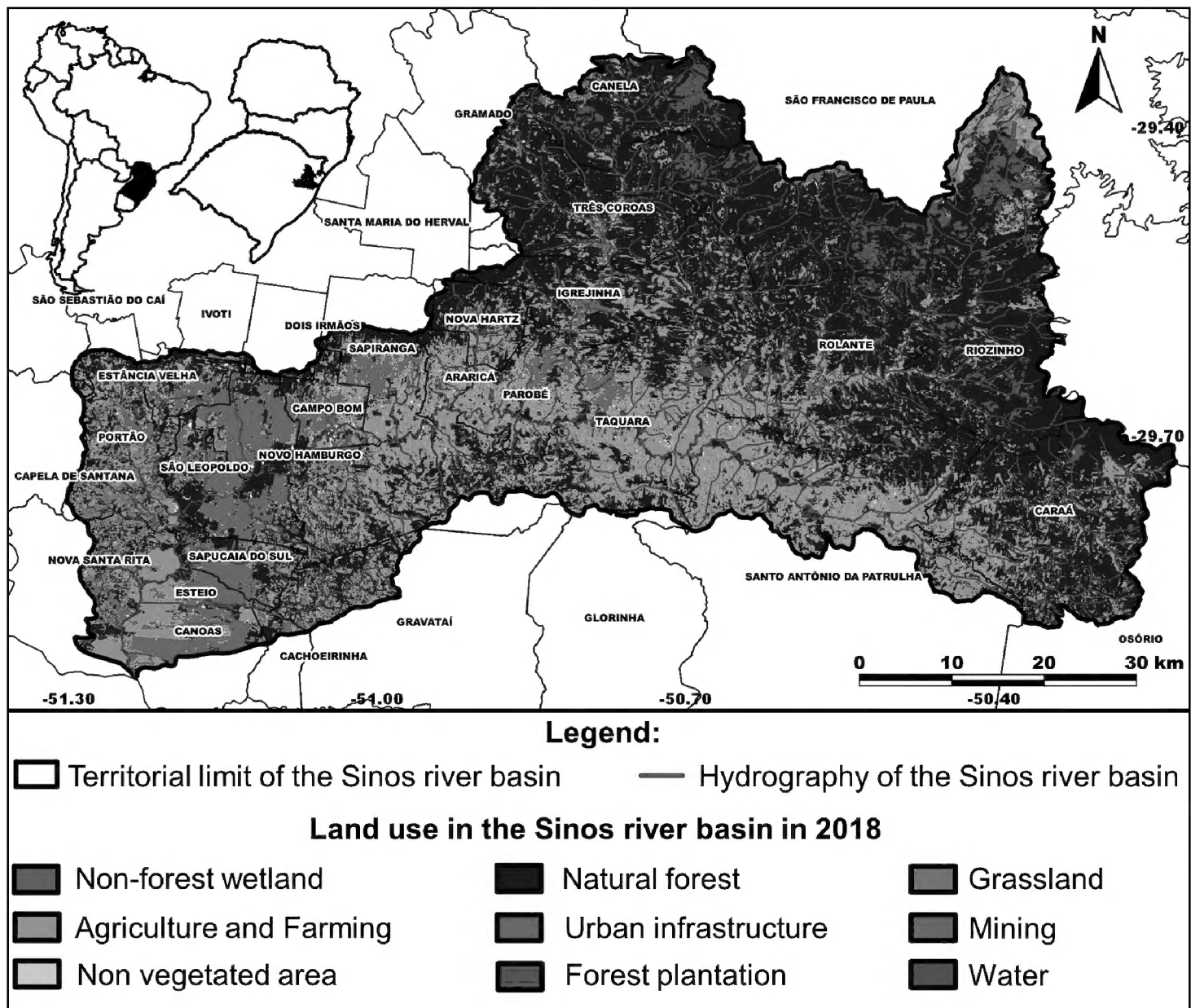
Brazil harbours the greatest richness of amphibian species in the world, with 1188 species currently known from its territory (Segalla et al. 2021). This diversity has been threatened especially due to habitat loss and fragmentation (Becker et al. 2007; Hayes et al. 2010). These habitats have been converted mainly into plantations, pasture and urban areas. In the State of Rio Grande do Sul, Brazil's extreme south, 109 amphibian species are known (LIVE 2014; Freire et al. 2016; Martins et al. 2017; Baldo et al. 2019), which corresponds to about 10% of Brazil's species. In the last decades, Rio Grande do Sul suffered a decrease of 20.7% of its natural cover due to human activities, which represents a loss rate of 845.04 km<sup>2</sup> per year (Cordeiro and Hasenack 2009). Currently, there is about 31.4% of the State's territory left with natural landscape (Cordeiro and Hasenack 2009). These data reinforce the importance of having more biodiversity inventories in regions that still contain remnants of natural habitats. Additionally, knowing the species that occur in a certain region reinforces its environmental and conservation importance. Regarding amphibians, this knowledge is also justifiable because of their role as indicators of environmental quality (Semlitsch 2003).

Although there are several amphibian-species lists for the State (e.g. Garcia and Vinciprova 2003; Borges-Martins et al. 2007; Machado and Maltchik 2007; Kwet et al. 2010; Maneyro et al. 2017; Martins et al. 2017), only one considered a whole river basin (Dalmolin et al. 2014). River basins, besides being ecological units, include extremely relevant areas for society due to the use of their water resources (e.g. Ross and Del Prette 1998; Tundisi 2008; Anschau 2016), soil for agriculture, mining, silviculture and pasture (Cordeiro and Hasenack 2009). Therefore, knowing the species richness of a river basin becomes a fundamental tool to help set strategies to manage its natural resources.

The Sinos River Basin incorporates a large part of Rio Grande do Sul's metropolitan region, having intense urbanisation and human activities (Anschau 2016). Although it is one of the most strategic river basins of the region because of both its location in an area of high demographic density and its relevance in terms of the biodiversity it harbours (Anschau 2016; Comitê Sinos 2020), this Basin still lacks a compiled amphibian list. Unfortunately, there are many other areas with high relevance in terms of biodiversity lacking inventories in Brazil (Oliveira et al. 2017). Therefore, this work aimed to list the amphibian species of the Sinos River Basin.

**Materials and methods****Study site**

The Sinos River Basin (SRB) is inserted in a region with a subtropical humid climate. It has an extension of about 4000 km<sup>2</sup> (Rolon et al. 2003) and is located in



**Figure 1.** Maps of land use in the Sinos River Basin in 2018, southern Brazil. Map elaborated using the data available at Projeto MapBiomas (<https://mapbiomas.org/>).

the northeast of the State of Rio Grande do Sul (29°39'0.94"S, 50°44'44.05"O), in southern Brazil, encompassing the southernmost portion of the Atlantic Forest remnants (Figure 1). This region has an urbanisation rate of 95%, which is above the regional mean (83%), besides a high demographic density of 342 inhabitants per km<sup>2</sup> (IBGE 2010). The Brazilian Annual Land Use and Land Cover Mapping Project (Projeto MapBiomas 2020) shows that about 1700 km<sup>2</sup> (almost half of the Basin's area) are covered by human-disturbed environments, including agriculture, livestock farming, mining, forestry and urban infrastructure (Figure 1). Despite this scenario, the Sinos River Basin includes remnants of habitats associated with the Pampa and Atlantic Forest, with important phytophysionomies of Rio Grande do Sul: Steppe (grasslands), Ombrophilous Forest, Dense Ombrophilous Forest, Mixed Ombrophilous Forest and Semi-deciduous Seasonal Forest (Mauhs 2013; Plano Sinos 2014; Molz et al. 2016). These forests are highly fragmented and the landscape is characterised by a mosaic of forest patches surrounded by grassland formations. These grasslands are regularly flooded, forming temporary wetlands (Mauhs 2013).

## Data survey in scientific collections

We compiled data from scientific collections and works published in the 32 Municipalities in the Sinos River Basin, viz. Cachoeirinha, Campo Bom, Canela, Canoas, Caraá, Dois Irmãos, Esteio, Glorinha, Gramado, Gravataí, Nova Santa Rita, Novo Hamburgo, Osório, Riozinho, Rolante, Santo Antônio da Patrulha, São Francisco de Paula, São Leopoldo, Sapucaia do Sul, Taquara and Três Coroas were the municipalities that contained records of amphibians.

We consulted three scientific collections: Amphibian Collection of the Museum of Science and Technology of the Pontifícia Universidade Católica do Rio Grande do Sul (MCT-PUCRS), Herpetological Collection of the Universidade Federal do Rio Grande do Sul (UFRGS) and Amphibian Collection of the Natural Sciences Museum of the Secretariat of Environment and Infrastructure of Rio Grande do Sul (MCN-SEMA). We visited all collections to confirm the identification of the specimens. For better visualisation of the points of species collection, we plotted a map with these points from the geographic coordinates in the collections' lists. Coordinates less than 1 km away from each other were grouped in the same locality within each Municipality.

To complement the data obtained from the scientific collections, we also compiled data from works that published records of amphibians in the Basin's Municipalities: Boulenger (1887), Milstead (1960), Braun and Braun (1980), Kwet and Di Bernardo (1998), Kwet (2001), Garcia and Vinciprova (2003), Colombo et al. (2007), Moreira et al. (2007), Moreira et al. (2008), Maltchik et al. (2008), Rodrigues et al. (2008), Kwet et al. (2010), ICMBio (2012), Toledo et al. (2014), Zank et al. (2014), Franz and Mello (2015), Alvares et al. (2015), Freire et al. (2016), Widholzer (2016), Dalmolin et al. (2017), Vargas et al. (2017), Sabbag et al. (2018) and Walker et al. (2018). We followed the taxonomy adopted in Segalla et al. (2021).

The conservation status of each species mentioned for the SRB was based on the state (LIVE 2014), national (ICMBio 2018) and global assessments (IUCN 2020).

## Results

We obtained the records with their respective geographic coordinates for 52 amphibian species (Table 1). Amongst these, only one belongs to the order Gymnophiona, all the others belonging to the order Anura. Regarding the conservation status, three of the anuran species are classified with some degree of threat at the state, national and/or global level: *Melanophryniscus cambaraensis*, *Melanophryniscus dorsalis* and *Thoropa saxatilis* (Table 1). Besides the 52 species, we recorded another 18 species collected in the Municipalities that integrate the SRB (Table 1) but without associated geographic coordinates. We chose to consider these species as potentially occurring in the SRB, as they may have been collected in localities outside of the Basin's limits. However, the probability of their inclusion in the list is high, as discussed below. Considering these additional records, we have an estimation of 70 amphibian

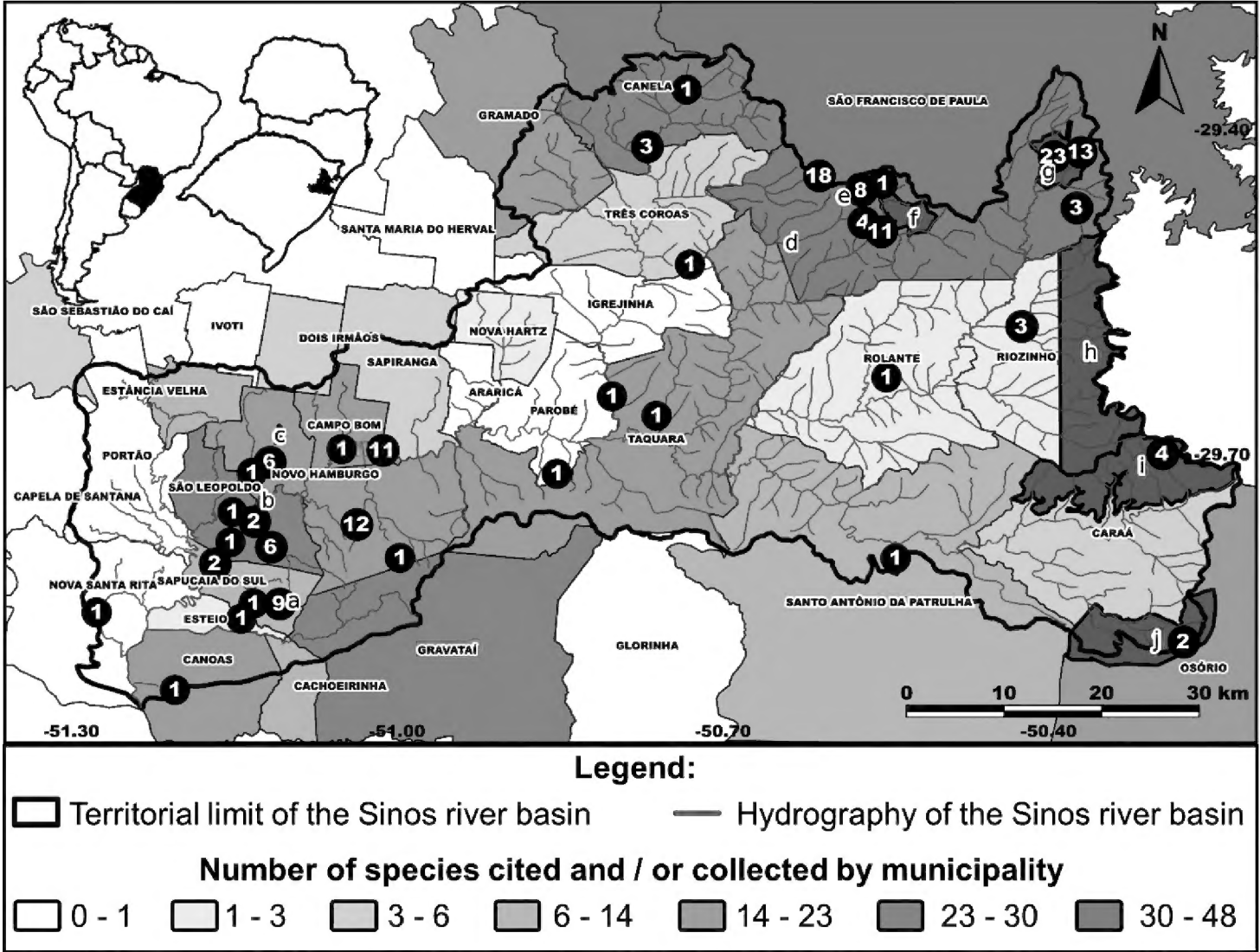


**Table 1.** List of species recorded in the Municipalities of the Sinos River Basin, southern Brazil. The highlighted Municipalities are those with the occurrence of species mentioned in literature that was used to compile the list, but that do not necessarily have occurrence localities inside the Basin. Asterisks indicate species without associated geographic coordinates. Regarding Conservation Status: St – state (LIVE 2014), Na – national, (ICMBio 2018) and Gl – global (IUCN 2020). CR: critically endangered, EN: endangered, VU: vulnerable, NT: near threatened, LC: least concern, DD: data deficient, NA: not applicable and NE: not evaluated.

Species	Municipalities	Conservation status		
		St	Na	Gl
ANURA				
Hylidae				
<i>Aplastodiscus perviridis</i> Lutz, 1950	Canela, Gramado, São Francisco de Paula	LC	LC	LC
<i>Boana joaquini</i> (Lutz, 1968)	Canela, Caraá, São Francisco de Paula	DD	LC	LC
<i>Boana bischoffi</i> (Boulenger, 1887)	São Francisco de Paula, Taquara	LC	LC	LC
<i>Boana faber</i> (Wied-Neuwied, 1821)	Campo Bom, Canela, Canoas, Novo Hamburgo, Osório, São Francisco de Paula, São Leopoldo, Sapiranga, Sapucaia do Sul, Taquara	LC	LC	LC
<i>Boana guentheri</i> (Boulenger, 1886)	Novo Hamburgo, Santo Antônio da Patrulha	LC	LC	LC
<i>Boana leptolineata</i> (Braun & Braun, 1977)	Canela, Gramado, Novo Hamburgo, São Francisco de Paula	LC	LC	LC
<i>Boana marginata</i> (Boulenger, 1887)	São Francisco de Paula, Taquara	LC	LC	LC
<i>Boana pulchella</i> (Duméril & Bibron, 1841)	Cachoeirinha, Campo Bom, Canela, Canoas, Gramado, Gravataí, Novo Hamburgo, Osório, Santo Antônio da Patrulha, São Francisco de Paula, Sapiranga, Sapucaia do Sul, Taquara	LC	LC	LC
<i>Dendropsophus microps</i> (Peters, 1872)*	São Francisco de Paula	LC	LC	LC
<i>Dendropsophus minutus</i> (Peters, 1872)	Cachoeirinha, Campo Bom, Canela, Canoas, Estância Velha, Esteio, Gramado, Gravataí, Osório, São Francisco de Paula, São Leopoldo, Sapiranga Taquara	LC	LC	LC
<i>Dendropsophus nanus</i> (Boulenger, 1889)*	Osório	LC	LC	LC
<i>Dendropsophus sanborni</i> (Schmidt, 1944)	Cachoeirinha, Canela, Canoas, Gramado, Gravataí, Novo Hamburgo, Osório, São Francisco de Paula, São Leopoldo, Taquara	LC	LC	LC
<i>Dendropsophus werneri</i> (Cochran, 1952)	São Leopoldo, Osório	NE	LC	LC
<i>Phyllomedusa distincta</i> Lutz, 1950*	São Francisco de Paula	EN	LC	LC
<i>Phyllomedusa iheringii</i> Boulenger, 1885*	Gravataí	LC	LC	LC
<i>Pseudis cardosoi</i> Kwet, 2000	Canela, Gramado, São Francisco de Paula	LC	LC	LC
<i>Pseudis minuta</i> Günther, 1858	Cachoeirinha, Campo Bom, Canoas, Gravataí, Novo Hamburgo, Osório, Santo Antônio da Patrulha, São Leopoldo, Taquara	LC	LC	LC
<i>Scinax aromothyella</i> (Faivovich, 2005)	Canela, São Francisco de Paula	LC	LC	DD
<i>Scinax berthae</i> (Barrio, 1962)*	Estância Velha, Gravataí, São Francisco de Paula	LC	LC	LC
<i>Scinax catharinae</i> (Boulenger, 1888)	Canela, Dois Irmãos, Gramado, São Francisco de Paula	LC	LC	LC
<i>Scinax fuscovarius</i> (Lutz, 1925)	Campo Bom, Canela, Canoas, Estância Velha, Gramado, Gravataí, Novo Hamburgo, Santo Antônio da Patrulha, São Francisco de Paula, São Leopoldo, Sapucaia do Sul, Taquara, Três Coroas	LC	LC	LC
<i>Scinax granulatus</i> (Peters, 1871)	Canela, Canoas, Gravataí, Novo Hamburgo, Portão, São Francisco de Paula, São Leopoldo, Taquara	LC	LC	LC
<i>Scinax nasicus</i> (Cope, 1862)	Canoas, Esteio, Gravataí, Nova Santa Rita	LC	LC	LC
<i>Scinax perereca</i> Pombal, Haddad & Kasahara, 1995	Gramado, São Francisco de Paula	LC	LC	LC
<i>Scinax rizibilis</i> (Bokermann, 1964)*	São Francisco de Paula	CR	LC	LC
<i>Scinax squalirostris</i> (Lutz, 1925)	Campo Bom, Canela, Canoas, Estância Velha, Gramado, Gravataí, Novo Hamburgo, Osório, Santo Antônio da Patrulha, São Francisco de Paula, São Leopoldo, Sapucaia do Sul, Taquara	LC	LC	LC
<i>Scinax tymbamirim</i> Nunes, Kwet & Pombal, 2012	Novo Hamburgo, São Francisco de Paula	LC	LC	NE
<i>Scinax uruguayus</i> (Schmidt, 1944)	São Francisco de Paula	LC	LC	LC
<i>Trachycephalus dibernardoi</i> Kwet & Solé, 2008*	São Francisco de Paula	DD	LC	LC
<i>Trachycephalus mesophaeus</i> (Hensel, 1867)	Campo Bom, Novo Hamburgo, São Leopoldo, Três Coroas	LC	LC	LC
Leptodactylidae				
<i>Adenomera araucaria</i> Kwet & Angulo, 2002	São Francisco de Paula	LC	LC	LC
<i>Leptodactylus fuscus</i> (Schneider, 1799)	Campo Bom, Novo Hamburgo	LC	LC	LC
<i>Leptodactylus gracilis</i> (Duméril & Bibron, 1840)	Cachoeirinha, Campo Bom, Gravataí, Novo Hamburgo, Osório, São Francisco de Paula, São Leopoldo, Taquara	LC	LC	LC

Species	Municipalities	Conservation status		
		St	Na	Gl
<i>Leptodactylus latinasus</i> Jiménez de la Espada, 1875	<b>Campo Bom</b> , Canoas, <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> Rolante, <b>São Leopoldo</b> , Sapucaia do Sul, <b>Taquara</b>	LC	LC	LC
<i>Leptodactylus luctator</i> (Hudson, 1892)	<b>Cachoeirinha</b> , Campo Bom, <b>Canela</b> , Canoas, <b>Gramado</b> , <b>Gravataí</b> , Nova Hartz, Novo Hamburgo, <b>Osório</b> , São Francisco de Paula, <b>São Leopoldo</b> , <b>Sapucaia do Sul</b> , <b>Taquara</b>	LC	LC	LC
<i>Leptodactylus mystacinus</i> (Burmeister, 1861)*	<b>Campo Bom</b> , Estância Velha, Gravataí, São Francisco de Paula, <b>São Leopoldo</b> , <b>Taquara</b>	LC	LC	LC
<i>Leptodactylus plaumanni</i> Ahl, 1936	São Francisco de Paula	LC	LC	LC
<i>Physalaemus biligonigerus</i> (Cope, 1861)	Campo Bom, <b>Canela</b> , Canoas, Estância Velha, <b>Gravataí</b> , <b>Osório</b> , <b>Santo Antônio da Patrulha</b> , <b>São Leopoldo</b> , <b>Sapucaia do Sul</b>	LC	LC	LC
<i>Physalaemus cuvieri</i> Fitzinger, 1826	<b>Cachoeirinha</b> , <b>Campo Bom</b> , <b>Canela</b> , Canoas, Estância Velha, <b>Gramado</b> , <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> , São Francisco de Paula, São Leopoldo, <b>Sapucaia do Sul</b> , <b>Taquara</b>	LC	LC	LC
<i>Physalaemus gracilis</i> (Boulenger, 1883)	<b>Cachoeirinha</b> , <b>Campo Bom</b> , <b>Canela</b> , Canoas, Estância Velha, <b>Gramado</b> , <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> , São Francisco de Paula, São Leopoldo, Sapiranga, Sapucaia do Sul, <b>Taquara</b>	LC	LC	LC
<i>Physalaemus henselii</i> (Peters, 1872)*	Cachoeirinha, <b>Canela</b> , Canoas, <b>Gramado</b> , <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> , <b>Santo Antônio da Patrulha</b> , São Francisco de Paula, <b>São Leopoldo</b> , Três Coroas	LC	LC	LC
<i>Physalaemus lisei</i> Braun & Braun, 1977	<b>Canela</b> , <b>Gramado</b> , Gravataí, Novo Hamburgo, São Francisco de Paula, <b>São Leopoldo</b> , <b>Taquara</b>	LC	LC	LC
<i>Physalaemus nanus</i> (Boulenger, 1888)*	<b>São Francisco de Paula</b>	LC	LC	LC
<i>Physalaemus riograndensis</i> Milstead, 1960*	<b>Osório</b>	LC	LC	LC
<i>Pleurodema bibroni</i> Tschudi, 1838	São Francisco de Paula	DD	LC	NT
<i>Pseudopaludicola falcipes</i> (Hensel, 1867)	<b>Cachoeirinha</b> , Campo Bom, <b>Canela</b> , Canoas, <b>Gramado</b> , <b>Gravataí</b> , Nova Hartz, Novo Hamburgo, <b>Osório</b> , <b>Santo Antônio da Patrulha</b> , <b>São Leopoldo</b> , Sapucaia do Sul, <b>Taquara</b>	LC	LC	LC
<b>Bufonidae</b>				
<i>Melanophryniscus atroluteus</i> (Miranda-Ribeiro, 1920)*	<b>Campo Bom</b> , Canoas	LC	LC	LC
<i>Melanophryniscus cambaraensis</i> Braun & Braun, 1979	São Francisco de Paula	VU	VU	DD
<i>Melanophryniscus dorsalis</i> (Mertens, 1933)	<b>Gravataí</b> , São Leopoldo	EN	VU	VU
<i>Melanophryniscus simplex</i> Caramaschi & Cruz, 2002*	<b>Canela</b> , São Francisco de Paula	LC	LC	DD
<i>Melanophryniscus tumifrons</i> (Boulenger, 1905)	<b>Campo Bom</b> , <b>Gravataí</b> , Novo Hamburgo, Parobé, Santo Antônio da Patrulha, São Leopoldo	DD	LC	LC
<i>Rhinella achavali</i> (Maneyro, Arrieta, and de Sá, 2004)	Taquara	LC	LC	LC
<i>Rhinella arenarum</i> (Hensel, 1867)*	<b>Osório</b> , <b>Santo Antônio da Patrulha</b>	LC	LC	LC
<i>Rhinella dorbignyi</i> (Duméril & Bibron, 1841)*	<b>Cachoeirinha</b> , <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> , <b>São Leopoldo</b> , <b>Sapucaia do Sul</b>	LC	LC	LC
<i>Rhinella henseli</i> (Lutz, 1934)	<b>Campo Bom</b> , <b>Canela</b> , <b>Gramado</b> São Francisco de Paula, <b>São Leopoldo</b> , <b>São Sebastião do Caí</b>	LC	LC	LC
<i>Rhinella icterica</i> (Spix, 1824)	<b>Cachoeirinha</b> , <b>Campo Bom</b> , <b>Canela</b> , Canoas, Dois Irmãos, <b>Esteio</b> , Glorinha, <b>Gramado</b> , Gravataí, Novo Hamburgo, Osório, Riozinho, <b>Rolante</b> , Santo Antônio da Patrulha, São Francisco de Paula, <b>São Leopoldo</b> , Sapiranga, <b>Sapucaia do Sul</b> , <b>Taquara</b> , Três Coroas	LC	LC	LC
<i>Rhinella ornata</i> (Spix, 1824)	Caraá	LC	LC	LC
<b>Cycloramphidae</b>				
<i>Limnomedusa macroglossa</i> (Duméril & Bibron, 1841)*	<b>São Francisco de Paula</b>	LC	LC	LC
<i>Thoropa saxatilis</i> Cocroft & Heyer, 1988	<b>Dois Irmãos</b> , Riozinho, São Francisco de Paula, <b>Sapiranga</b>	EN	VU	NT
<b>Odontophrynidae</b>				
<i>Odontophrynus americanus</i> (Duméril & Bibron, 1841)	<b>Cachoeirinha</b> , Campo Bom, <b>Canela</b> , Canoas, <b>Gravataí</b> , Novo Hamburgo, <b>Osório</b> , São Francisco de Paula, <b>São Leopoldo</b> , Sapucaia do Sul	LC	LC	LC
<i>Odontophrynus maisuma</i> Rosset, 2008*	Osório	LC	LC	NE
<i>Proceratophrys bigibbosa</i> (Peters, 1872)	<b>Canela</b> , São Francisco de Paula	LC	LC	NT
<i>Proceratophrys brauni</i> Kwet & Faivovich, 2001*	<b>São Francisco de Paula</b>	LC	LC	DD
<b>Microhylidae</b>				
<i>Elachistocleis bicolor</i> (Guérin-Méneville, 1838)	<b>Cachoeirinha</b> , <b>Campo Bom</b> , Canoas, Estância Velha, Gramado, <b>Gravataí</b> , Novo Hamburgo, , São Francisco de Paula, São Leopoldo	LC	LC	LC

Species	Municipalities	Conservation status		
		St	Na	Gl
<i>Elachistocleis erythrogaster</i> Kwet & Di-Bernardo, 1998*	São Francisco de Paula	DD	DD	NT
<b>Brachycephalidae</b>				
<i>Ischnocnema henselii</i> (Peters, 1870)	Canela, Gravataí, São Francisco de Paula	LC	LC	LC
<b>Centrolenidae</b>				
<i>Vitreorana uranoscopa</i> (Müller, 1924)	Dois Irmãos, Riozinho	NT	LC	LC
<b>Hemiphractidae</b>				
<i>Fritziana mitus</i> Walker, Wachlevski, Nogueira da Costa, Nogueira-Costa, Garcia & Haddad, 2018	Caraá, Osório	NE	NE	NE
<b>Hylodidae</b>				
<i>Hylodes meridionalis</i> (Mertens, 1927)	Canela, Caraá, Gramado, São Francisco de Paula	NT	LC	LC
<b>Ranidae</b>				
<i>Aquarana catesbeiana</i> (Shaw, 1802)	Gravataí, Sapucaia do Sul	NA	NA	LC
<b>GYMNOPHIONA</b>				
<b>Typhlonectidae</b>				
<i>Chthonerpeton indistinctum</i> (Reinhardt & Lütken, 1862)	Canoas, Gravataí, São Leopoldo, Sapucaia do Sul, Taquara	LC	LC	LC



**Figure 2.** Number of species recorded by occurrence locality and by Municipality in the Sinos River Basin, southern Brazil. The numbers in black circles (1 to 23) indicate the number of species per locality inside each Municipality (see Material and Methods for details). Green areas are conservation units: a) Fazenda Morro de Sapucaia Federal Private Reserve (RPPN), b) Imperatriz Leopoldina Municipal Natural Park (PNM), c) Area of Relevant Ecological Interest (ARIE) Henrique Luiz Roessler, d) Rancho Mira-Serra Federal RPPN, e) ARIE São Bernardo, f) Ronda PNM, g) São Francisco de Paula National Forest, h) Area of Environmental Protection (APA) of Riozinho, i) APA of Caraá and j) APA Morro de Osório.

species for the SRB, which makes up more than half of the species mentioned for Rio Grande do Sul until now. Of the 32 Municipalities of the SRB, 26 have records of amphibians (Table 1, Figure 2). São Francisco de Paula has the largest number of species, with 48 records for this Municipality, but only 30 with the Basin's limits. Nineteen municipalities have less than 10 recorded species (Table 1, Figure 2).

Regarding the occurrence localities (collection sites inside each Municipality), the São Francisco de Paula National Forest has the largest number of species (23), followed by the locality of Boca da Serra (18), both in the Municipality of São Francisco de Paula (Figure 2).

## Discussion

Considering the 52 species with geographic coordinates within the limits of the SRB, plus the 18 species with expected occurrence (with record for the Municipalities, but without coordinates), we conclude that the Basin harbours more than half of the species of the State of Rio Grande do Sul. We think it is likely that the species of potential occurrence will occur on the list since there are neither physical barriers nor a drastic break in habitat between the limits of the Basin and other regions of the respective Municipalities of these records. Additionally, most species are not habitat-specific, being somewhat tolerant to environmental changes, which is the case of *Physalaemus henselii*, *Pseudis minuta* and *Rhinella dorbignyi*, amongst others. We chose not to include them as a preventative measure since the Basin includes a small fraction of some of these Municipalities.

Despite the SRB encompassing about half of all species of pampa and forests habitats of the extreme south of Brazil, we point out that this is a significant fraction of regional diversity. This conclusion is based on the fact that Sinos Basin is a densely populated region, great impacted by anthropogenic stressors from urban, industry and agriculture. Despite this being little speculative, we consider that anuran diversity is supported by the great environmental heterogeneity generated by the interface between Pampa and Atlantic Forest (Mauhs 2013). At the same time, the small number of specimens from the SRB in the consulted scientific collections is striking, indicating that this region is still poorly surveyed. There is a great concentration of specimens from few localities, one example being the São Francisco de Paula National Forest. This is a conservation unit that has a tradition of cooperation with research institutions, which led to a large number of specimens housed in scientific collections. Other conservation units show the opposite scenario and these are the areas where new species and species distributions are expected to occur, especially conservation units in the north-easternmost portion of the basin, such as the Areas of Environmental Protection of Riozinho and Caraá that still concentrate large remnants of Dense Ombrophilous Forest. Surveys in these areas can provide important records not only for the management of these units, but also for the Basin as a whole since they contain the main headwaters of the Sinos River.

Only three localities of the Basin have records of species that are threatened or otherwise of conservation interest. Amongst them, we highlight the lowest portion



of the SRB near the Municipalities of Campo Bom, Novo Hamburgo, São Leopoldo and Sapiranga, where, in a locality of São Leopoldo, *Melanophryniscus dorsalis* has been recorded (Zank et al. 2014). This species is threatened with extinction at regional, national and global levels and depends on temporary water bodies for reproduction (LIVE 2014; ICMBio 2018). The region of the record is one of the most urbanised and disturbed in the Basin, but there are still some wetland remnants (Maltchik et al. 2016), being likely one of the most threatened habitats in the SRB. *M. dorsalis* may occur in more localities of this region, which would strengthen the importance of these wetland remnants as conservation refuges in the Basin. Although some specimens are recorded in collections, the collection efforts are insufficient and do not reveal the actual species richness or distribution in this region. Another important species of this genus is *M. cambaraensis*, whose only recorded population is in the São Francisco de Paula National Forest. Despite systematic searches, this toad has not been found in its type locality in Fortaleza dos Aparados, Serra Geral National Park, Municipality of Cambará do Sul anymore (Caorsi 2014). It is also not found in other regions with intensive collection efforts around the National Forest. Another relevant species in terms of conservation is the glass frog *Vitreorana uranoscopa*, which had already been recorded for other localities in northern and north-eastern Rio Grande do Sul (Machado et al. 2016). We found vocalising individuals and egg masses on leaves at the margins of the river in a forest region in the Municipality of Dois Irmãos; however, there are no housed specimens in the scientific collections (Iberê F. Machado pers. comm.).

For two species, we updated their occurrence inside the Basin and its Municipalities, viz. *Melanophryniscus atroluteus* and *M. tumifrons*. The first had already been mentioned for the Municipality of São Leopoldo by Braun and Braun (1980). However, the specimens housed in the collection of MCN-SEMA for this Municipality belong to *Melanophryniscus dorsalis* (Zank et al. 2014). Specimens of *Melanophryniscus tumifrons* from Canela, São Francisco de Paula and regions of the Basin with higher altitudes are of *M. simplex* (Colombo et al. 2007; Zank et al. 2014). Reports of *M. tumifrons* from the Municipalities of Campo Bom, Gravataí, Novo Hamburgo, Parobé, Santo Antônio da Patrulha and São Leopoldo may be of a yet undescribed species of *Melanophryniscus* (Baldo et al. 2014).

By contrast, some species with specific habitat requirements may not be found in some of the regions anymore, such as *Elachistocleis erythrogaster*. Individuals of this species were found in areas of native grassland formations in the north-western headwaters of the Sinos River Basin (Kwet and Di-Bernardo 1998), which are disappearing quickly, so that collection efforts do not follow the rate of land-use change of these areas. In this region of the Basin, grasslands are the habitats that have suffered the greatest loss in the past 30 years, being converted into areas of forestry and a variety of crops (Projeto MapBiomias 2020).

Two species mentioned in other studies of Municipalities in the Basin were not recorded. Those are *Bokermannohyla circumdata* (Lutz, 1973) and *Leptodactylus mystaceus* Braun and Braun (1980). According to Napoli (2000), there is no material evidence of *B. circumdata* in Rio Grande do Sul. This is a medium-sized species that

is common in medium to high altitudes (Napoli 2000). Despite the records of Lutz (1973), it was not mentioned anymore in surveys of regions near that of our study. However, recently, one specimen was photographed (Paola Prates Stumpf, pers. comm.) in the Municipality of Praia Grande, Santa Catarina, near the border with Rio Grande Sul, indicating that the species may occur in Rio Grande do Sul and that the record mentioned by Lutz (1973) may be valid. Braun and Braun (1980) mention *Leptodactylus mystaceus* for the Municipalities of Canela and Porto Alegre. In the latter, the specimens in the collection of MCN-SEMA refer to *L. luctator* (*L. latrans* in Fonte et al. 2013). However, there is no reference material. This species has a broad distribution in South America (Frost 2020) and is relatively common where it occurs. In a distribution map presented by Affonso et al. (2014), the southernmost mentioned record is the Municipality of Maringá in the State of Paraná. Thus, we estimate that *L. mystaceus* does not occur in Canela or anywhere else in Rio Grande do Sul.

Another relevant species is *Aquarana catesbeiana* (previously in the genus *Lithobates*), an under-reported species in scientific collections and publications that may have a broader distribution in the SRB due to the presence of many rural areas with reservoirs and small dams (Madalozzo et al. 2016). We highlight that its record is essential and it must be better mapped in future works since it is an important threatening factor for the native amphibian fauna (Boelter et al. 2012; Both and Grant 2012; Madalozzo et al. 2016).

The number of records obtained from the scientific collections may not represent the actual species richness in the Basin. This is a surprising scenario because the Basin is near important urban centres with research institutions, as well as the three main herpetological collections of the State. Sampling efforts of the herpetofauna in the SRB, including those directed to the studies of environmental licensing, have focused on eventual visits to many localities of the region and did not necessarily lead to the collection of material or this was not housed in scientific collections.

## Conclusions

Our work reveals that, despite the intense human impact, the SRB harbours a high amphibian species richness. The expansion of urban and agricultural areas of this region has already been related to a reduction in the anuran community (Oro 2016) and may lead rare or poorly-recorded species to local extinction. The large number of species that potentially occur in the Basin indicates that this area is extremely important for the conservation of amphibians in Rio Grande do Sul and southern Brazil. However, this region lacks systematic species inventories with the proper record of material in scientific collections. Fieldwork that does not lead to collection and housing in scientific collections limits the decision-making about the environmental management of this important river basin not only from an environmental, but also from an economic perspective. The increasing number of herpetology researchers in Brazil and Rio Grande do Sul and the increasingly accessible geoprocessing tools, make it essential for information to have a minimum quality, especially regarding the accurate determination of collection sites.

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